The Additive Effects of Scripted Lessons Plus Guided Notes on Science Quiz Scores of Students With Intellectual Disability and Autism

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Abstract:

This study examined the effects of scripted lessons (SLs) alone and in combination with guided notes during science instruction on science quiz scores of three elementary students with moderate to severe intellectual disability and autism. This study used a multiple probe across three science units design with replication across students and included four conditions of baseline, SLs, scripted lessons plus guided notes (SLs + GNs), and maintenance. Results showed a change in level from baseline to the SLs condition for all three participants and additional slight improvement in scores during the SLs + GNs condition for two participants. Furthermore, acquisition of science content was maintained over time for all participants. Implications for research and practice are discussed.

Keywords: scripted lessons | guided notes | science instruction | students with intellectual disability | students with autism

Article:

The Individuals With Disabilities Education Improvement Act (IDEA) of 2004 and the No Child Left Behind Act (NCLB) of 2001 emphasized that students with disabilities should have the same opportunities to learn and be held to the high standards as their nondisabled, same-age peers by accessing and participating in the general education curriculum. This requirement in federal legislation led to a shift in attitude toward teaching students with moderate to severe intellectual disability in that special education services for these students should go beyond simply teaching self-help and life skills in isolated settings (Downing & MacFarland, 2010). Providing academic instruction that addresses language arts, mathematics, and science standards for these students becomes an important agenda for special educators.

Science education is important because an understanding of science offers students the ability to question their own lives and formulate thinking to make informed decisions. Scientific thinking will enhance the capability of all students to hold meaningful and productive jobs in the future, with the ability to learn, reason, think creatively, make decisions, and solve problems (National Research Council [NRC], 1996). In science education, standards-based reform, fueled by *A Nation at Risk* (1983) and *Project 2061: Science for All Americans* (1990), led to the development of the National Science Education Standards in 1996 for all students. The importance of effective science instruction for all students, including those with moderate to severe intellectual disability, is undisputed. However, despite the emphasis on “what to teach” from these federal regulations and movements, there is very little evidence on “how to teach” academic content to students with moderate to severe intellectual disability. Although some research exists on methods for teaching mathematics and reading to students with moderate to severe intellectual disability (e.g., Browder, Spooner, Ahlgrim-Dezell, Harris, & Wakeman, 2008; Browder, Wakeman, Spooner, Ahlgrim-Dezell, & Algozzine, 2006), very little research exists on methods for teaching science content to students with significant cognitive disabilities (Courtade, Spooner, & Browder, 2007; Spooner, Knight, Browder, Jimenez, & DiBiase, 2011).

Courtade et al. (2007) conducted a comprehensive literature review on identifying research involving effective science instruction that linked to the National Science Education Standards for students with significant cognitive disabilities. Only 11 studies were identified, with 8 of those linking to only 1 content standard: *Science in Personal and Social Perspectives*. One commonality identified in all 11 studies was the use of systematic response prompting methods, such as time delay and modeling, to promote students’ science achievements. When teaching students with moderate to severe intellectual disability, teachers may benefit from scripted lessons (SLs). SLs are viewed as an effective instructional strategy for students with mild disabilities, as they are important for student achievement and teacher accountability (Hummel, Venn, & Gunter, 2004). SLs are defined as explicit instructional lessons developed and implemented by the teacher, which utilize systematic methods for teaching content to ensure students have sufficient information to formulate correct responses about the content (Gunter & Reed, 1997). They specify how the teacher is going to present the content, narrate exactly what the teacher is going to say to explain the academic content, pose questions the teacher will ask the students, and provide correct student responses (Carnine, Silbert, Kame’enui, & Tarver, 2010). The primary goal of SLs is to ensure that the teacher delivers pertinent information on the content to the students.

SLs are created following a precise process that begins by gaining the learners’ attention, linking to prior knowledge and/or reviewing the previous information learned, and clearly stating the objective(s) of the lesson, followed by guided practice that involves MODEL, PROMPT, and CHECK steps (Gunter & Reed, 1997). The MODEL step consists of an errorless learning phase where the teacher will explicitly model the content verbally, with written instructions, pictures, or via a demonstration. The PROMPT step provides an informal way for the teacher to assess students' learning by having students simultaneously perform the desired behaviors using some type of stimulus prompting along with the teacher. The CHECK step consists of having the student perform the desired behavior independently or in a group and providing performance feedback.

The final component of SLs involves implementing independent practice in order for the teacher to assess student understanding and retention of information, which can be given for a number of days after the initial presentation of the content (Gunter & Reed, 1997; Hummel et al., 2004). Furthermore, SLs have been found to be most effective for students with mild disabilities when they embed effective instructional practices within the lesson, such as simultaneous prompting, error correction procedures, or thinning of reinforcement schedules (Gunter & Reed, 1997).

To support students with moderate to severe intellectual disability in making successful academic gains, some forms of systematic and direct instruction approaches are also beneficial and have been found to be effective, including time delay, least intrusive prompting, discrimination training (i.e., example/nonexample training), and specific feedback (e.g., Ault, Wolery, Doyle, & Gast, 1989; Browder & Cooper-Duffy, 2003; Browder, Courtade-Little, Wakeman, & Rickelman, 2006; Browder et al., 2008; Browder & Spooner, 2006; Browder, Wakeman, et al., 2006; Bursuck & Damer, 2007; Downing, 2008; Doyle & Gast, 1990; Gast & Doyle, 1991; Gunter & Reed, 1997; Gursel, Tekin-Iftar, & Boskurt, 2006). For example, several curricula have been developed with research support which include SLs with embedded systematic instruction for students with moderate to severe intellectual disability, including *Early Literacy Skills Builder* (Browder, Gibbs, Ahlgrim-Delzell, Courtade, & Lee, 2007), *Teaching to Standards: SCIENCE* (Courtade, Jimenez, Trela, & Browder, 2008), and *Teaching to Standards: MATH* (Trela, Jimenez, & Browder, 2008).

One possible downside of SLs is their reliance on observational learning and auditory processing. A common characteristic among students with intellectual disability and autism is delays in auditory processing, making reliance on speech as the only modality of instruction difficult for this student population (Abbeduto & Nuccio, 1991). Guided notes provide a means to increase student learning and understanding of content through the use of multiple modalities (i.e., auditory, visual, and tactile) and may be used to support students with moderate to severe intellectual disability and autism. Guided notes are defined as an outline of the lecture with blanks inserted where students are to fill in key concepts and examples from the lesson; thereby, the material delivery is presented in a concise, visual format (Stringfellow & Miller, 2005). Benefits of using guided notes include increased active student participation, improved academic achievement, reduced frustration in students, their low cost, and ensuring that students are indeed receiving key information which will be later assessed (Konrad, Joseph, & Eveleigh, 2009; Lazarus, 1991).

Konrad and colleagues (2009) conducted a meta-analysis on guided notes instruction and suggested that academic performances of students may be strengthened when guided notes are combined with systematic instruction methods and that teachers who use guided notes with their lectures may be more likely to stay on topic and provide pertinent information.

Despite the emerging academic instruction for students with moderate to severe intellectual disability, the current literature is limited by instructional strategies employed (e.g., time delay, system of least prompts) and breadth of science content taught (Courtade et al., 2007). This study was designed to address these limitations by using SLs embedding systematic instruction combined with guided notes to enhance science learning across three units of science, which incorporated multiple standards of *Earth and Space Science*, *Life Science*, *Physical Science*, and *Science as Inquiry*, for students with moderate to severe intellectual disability. Specifically, the purpose of this study was to examine the effects of SLs alone and in combination with guided notes during science instruction on science quiz scores of three elementary students with moderate to severe intellectual disability and autism.

Table 1. Results of Psychological, Adaptive, and Achievement Tests for All Participants.

Participants	**Leiter-R[a] IQ score**	**CARS**	**Vineland-II[b] Adaptive behavior composite score**	**Reading ability**	**Expressive language score**	**Receptive language score (ROWPVT[c])**
Kevin	99 (47th percentile)	Unavailable	64, “low range”	Basic Reading, 52[d], “severely below average”	79[e], “slightly below average”	94, “average”
Jamall	90 (25th percentile)	35, “mildly moderately autistic range”	58,“low range”	Reading quotient 64,<1%[f]	Age equivalent: 13−16 months[g]	83, “slightly below average”
Jackie	71 (no percentile reported)	36, “mildly moderately autistic range”	58, “low range”	preK-1st grade, 0 months[h]	Age equivalent: 18−21 months[g]	Age equivalent: 1 yr, 11 months

Abbreviations: ROWPVT = Receptive One-Word Picture Vocabulary Test; CARS = Childhood Autism Rating Scale. [a]Leiter International Performance Scale−Revised. [b]Vineland Adaptive Behavior Scales (2nd ed.). [c]Receptive One-Word Picture Vocabulary Test (ROWPVT; 3rd ed.). dWoodcock Johnson® III Normative Update (NU) Tests of Achievement. [e]Oral and Written Language Scales (OWLS). [f]Test of Early Reading Ability (TERA-3). [g]Nonspeech Test for Receptive/Expressive Language. [h]BRIGANCE® Comprehensive Inventory of Basic Skills (CIBS).

Method

Participants

Three students with moderate to severe intellectual disability and autism in third and fourth grades participated in this study. Participants were selected by convenience sampling via a recommendation from the school system contact. All participants met the following criteria: (a) had a diagnosis of intellectual disability and autism; (b) had a consistent response mode; (c) were able to generate their own answers via verbal, pictorial, or gestural responses; and (d) accessed alternate achievement standards according to the State's alternative content standards. Kevin was a 9-year-old African American male in third grade with moderate autism and intellectual disability. He communicated verbally, but he exhibited many problem behaviors, such as frequent off-task behavior (e.g., staring into space), refusal to work, and whining or crying when he did not know an answer to a question. He read on a first-grade level. Kevin attended a general education science class once per week for 30 min throughout the duration of the study. Jamall was a 9-year-old African American male in fourth grade and was diagnosed with moderate autism and intellectual disability. He communicated verbally, but his speech often was unintelligible so he used a communication book with pictures if needed. He read on a first-grade level. Jackie is a 9-year-old African American female in third grade with severe autism and moderate intellectual disability. She had limited functional communication and exhibited echolalia. She was an emergent reader. See Table 1 for the results of psychological, adaptive, and achievement tests for each of the participants.

Setting

The setting of the study was an elementary school in a large metropolitan city in the southeast United States. The school's demographic composition was as follows: 33.2% African American, 23.3% White, 32.6% Hispanic, 1.6% Asian, and 9.3% other. Approximately 74% of the students were considered "economically disadvantaged." All participants received the majority of their instruction in a self-contained special education classroom, with a total of six students with autism in second through fifth grades, one special educator, and one paraprofessional. The participants attended special area classes, such as computer, art, and music with their same age, typically developing peers. All science lessons took place at a large rectangular table in the back corner of the mobile unit, where all group work sessions were held.

Materials

The materials used in this study included the following: a binder with three content units of SL plans (e.g., Life Cycle unit, Rock Cycle unit, and Senses unit), student assessments, vocabulary words and pictures, concept statements for each lesson, and any science-related materials needed for the lessons (e.g., rocks, minerals, life cycle chart, food items for tasting and smelling). All materials used, with the exception of the guided notes portion of the intervention, were from the *Early Science* curriculum (Jimenez, Knight, & Browder, in press). The *Early Science* curriculum is a research-based science curriculum, aligned to national science content standards, for students with severe disabilities.

The curriculum uses an inquiry-based science approach. The content was selected and validated by national experts in science education, and the instructional strategies embedded in the scripted curriculum (including explicit instruction, model-lead-test, constant time delay, and least intrusive prompting) were selected by special education experts based on their sound research base for teaching this population of students. For the last three lessons of each unit that were conducted under the scripted lessons plus guided notes (SLs + GNs) condition, the teacher was supplied with a presentation tablet with the teacher model of guided notes supported by picture symbols and guided notes handouts for each participant. Each lesson plan was 7 to 10 pages in length and included lesson objectives, a list of materials needed, detailed scripts for the teacher, student performance expectations and response options, and strategies for prompting/feedback. All lesson plans were designed to include the essential components of inquiry (i.e., engage, investigate, describe, explain, report). In addition, the second and third units included a KWHL (what do you *K*now, what do you *W*ant to know, *H*ow will you find out, what did you *L*earn) graphic organizer (Browder et al., 2010; Jimenez, Browder, & Courtade, 2009) as a component of the SL plans. A poster of the KWHL chart was displayed on the white board and was completed by the teacher and students during the lesson (e.g., students placed the learned concept statement from the lesson under the “L” for what they learned on the KWHL chart).

For Jackie, who exhibited echolalia in response to verbally presented open-ended questions (e.g., responding “live” when prompted, “Name three things that plants and animals need to live”), an additional material was included to assist her with communication across all three units. The material included a unit choice board of 18 choices (each accompanied with a picture) that reflected all of the possible answers for the open-ended questions in each unit.

Experimenters and Interventionist

A doctoral-level graduate research assistant (i.e., primary experimenter) and one postdoctoral research assistant (i.e., secondary experimenter) in special education served as the trainers and data collectors. Both trainers had prior experience with conducting research with students with moderate to severe disabilities. In addition, both trainers had extensive training and practical teaching experience providing academic instruction to students with intellectual disability and autism using the principles of systematic instruction.

The special education classroom teacher served as the primary interventionist to implement the scripted science lessons and guided notes instruction. She was certified to teach K-12 students with moderate to severe disabilities and had 6 years of teaching experience in a self-contained classroom for students with autism. She demonstrated 100% procedural fidelity during training prior to starting the respective interventions.

Dependent Variable and Measurement

The dependent variable was the number of points each participant earned on daily science quizzes across the three science content units. There were five questions on each quiz, including one identification question (1 point), one application of concept training from the SL (2 points), one vocabulary (2 points), one comprehension of key concept (2 points), and one open-ended question (3 points), worth a total of 10 points. No partial point for a question was used for scoring.

The questions were formatted the same across all quizzes. All key text (e.g., water, animals, gold, colors) in the answer choices were presented with pictorial supports with the exception of questions targeting vocabulary identification.

Each quiz for a lesson was administered four times, including a pretest (Day 1 prior to the lesson) and three assessments (at the end of each daily lesson) across three instructional days on which the same lesson was repeated. Although the questions on the quizzes for each lesson remained the same, the position of answers in each quiz was randomly ordered daily to control for practice effects and to prevent rote memorization of responses from the participants. In addition, multiple exemplars of pictorial supports (e.g., three different pictures of “moon”) were used on daily quizzes to measure participants’ “true” learning.

The special education classroom teacher administered the science quizzes with each participant individually. The teacher read aloud one question at a time and then prompted, “Circle your answer” for the student to choose from one correct answer and three distracters or to generate his or her own response for the open-ended question. The teacher waited for the student to provide an answer before reading the next question to the student. If the student did not initiate a response within 5 s, the teacher reread the question and prompted, “Circle your answer.” No additional prompts were needed for any participant. No feedback was given to the student on his or her answers; however, the teacher provided intermittent praise to the student for responding to a question (e.g., “great job circling your answer.”). The primary experimenter scored all quizzes. The mastery criterion for each unit was participants’ earning an average of at least 8 points on the quizzes for a unit.

Experimental Design and Procedures

This study used a single-subject multiple probe across three science content units (i.e., Rock Cycle, Life Cycle, and Senses) design with replication across students (Horner & Baer, 1978). There were four conditions: (a) baseline, (b) SLs, (c) SLs + GNs, and (d) maintenance. Each unit consisted of six lessons. The SL condition was introduced first with the first three consecutive lessons (i.e., Lesson 1 [L1], Lesson 2 [L2], and Lesson 3 [L3]) of a unit. The SL + GN condition was then conducted with the last three consecutive lessons (i.e., L3, L4, and L5) of the same unit.

All lesson plans were developed to align with the general curriculum content and the State’s extended standards for upper elementary science. Each lesson took approximately 45 min to complete, including time taken for administering daily quizzes at the end of each lesson. Each of the six lessons was taught a total of three times to allow for repetition of materials and to provide opportunities to embed multiple exemplars within the instruction. Each unit lasted approximately 4 weeks from start to finish. Because all lessons were delivered in a group setting of six students, a decision to move on to the next condition was based on the completion of three instructional sessions per lesson for three lessons.

Baseline. To get a clear picture of the participants' science achievements prior to receiving interventions on content to be taught, all participants received quiz administration on each of the six lessons for all three science units. Specifically, during the initial baseline, 18 quizzes were administered with each participant in three different baseline sessions. The primary experimenter randomly selected two science quizzes from each of the three units (e.g., Lessons 2 and 5 for Unit 1, Lessons 3 and 4 for Unit 2, Lessons 1 and 2 for Unit 3) to probe in one session, for a total of six science quizzes per assessment session. Each participant was given the choice to have a short break between each quiz or continue completing the science quizzes without a break within the same session. As a result, baseline data were collected during a 3-day period during which the classroom teacher did not deliver any science instruction. Prior to baseline, students continued with their regular science instruction twice weekly, which were countywide, teacher developed lesson plans aligned with the State's extended content standards. Lessons varied, but typically consisted of science texts being read to students—often adapted with pictures, an experiment, or investigation—and students answering comprehension questions on the content taught.

Key vocabulary was taught using constant time delay; however, SLs with other essential components described previously were not available. At the time of this study, there were no research-based published curricula in science for students with severe disabilities; and therefore, teachers replied on "regular" countywide curriculum developed for students without disabilities and made adaptations for their individual students with severe disabilities.

After the initial baseline (i.e., first six data points), participants were probed weekly on randomly selected lessons within the units that were not under interventions, so that at least one quiz from each lesson was conducted. To ensure stable baseline measure and to detect any possible carryover effect, a pretest for each lesson was administered before beginning that lesson during the SL and SL + GN conditions (which is described below).

SLs. The classroom teacher taught the first three lessons of each unit using SLs only, from the *Early Science* curriculum (Jimenez et al., in press). SLs were defined as explicitly written science lessons with embedded direct instruction for teaching concepts (i.e., system of least intrusive prompts, time delay procedures, example/nonexample training, and specific praise). Blue text and icons on the scripts served as the discriminative stimuli for the teacher to know when to read the script and when to teach using systematic instruction.

The rationale for using SLs was to provide the teacher with a systematic method of delivering pertinent information to the students without erroneous or irrelevant teaching. The sequence of the SL included the following nine elements:

1. “Wonder” story: A literature-based component intended to promote meaning and personal relevance to the science content;

2. Constant time delay procedure to teach key vocabulary (i.e., 2−3 key words selected and taught per lesson);

3. Prediction of experiment or investigation outcomes;

4. Discrimination training to teach key concepts: example/nonexample training (i.e., this is ___, this is ____, this is ____, this is not ____, this is not _____);

5. Experiment or investigation conducted by teacher and students;

6. Description of observations (i.e., report the “L” part on KWHL chart);

7. Reexamination of prediction to make necessary changes if prediction was incorrect;

8. Model-lead-test concept statement: report findings by filling in a missing component of concept statement and add to the “L” part on KWHL chart (i.e., big idea of lesson, such as “We can ____ texture.” [feel]); and

9. Completion of science quiz individually.

A part of Figure 1 illustrates scripts the teacher was to follow and deliver.

SLs + GNs. The classroom teacher taught the last three lessons of each unit using SLs (as described previously) combined with guided notes instruction (see Figure 1 for a sample lesson). The guided notes were printed notes, accompanied by picture symbols, in which students had a visual stimulus (e.g., a box or a line) to signal inserting a picture or key term (see Figure 2). A visual discriminative stimulus (e.g., a notepad icon with highlighted text) was provided to the teacher to signal when to use the guided notes within the SL. A verbal discriminative stimulus (“This is really important!”) was provided by the teacher to signal the students when to input the key term or perform the key concept.

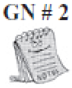
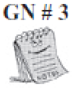
igMaterials & Directions	Teacher	Students	Prompts/ feedback	Student Response Options
 'Seeing Sound' Directions: Cut the fat end off of a balloon. Stretch the balloon over one end of the can so it makes a smooth drum-like surface. Attach a small piece of foil with a loop of tape from behind, to the center of the balloon. **GN # 2**  Verbal cue to fill-in notes: ***This is really important!*** GN # 3 	**See directions on pg. 9 for making instrument.  Experiment: ***We are going to make an instrument today with our materials. I would love it if you help me make an instrument to hear sound. Let's see if we can do it together.*** Create an instrument with the materials (See directions for 'Seeing Sound'). In a dim lit room with a flashlight, aim the reflection at the wall until you get a clear pattern from the foil. Then start making noises into the end of the can. Make a noise in one end of the can, the sound waves will hit the rubber balloon and make it vibrate too, in the exact same pattern as the sounds hitting it. ***Look at the wall. Do you see the light moving? That shows the sound waves vibrating, or moving. Those sound waves are what we hear. We hear the sound because of the sound waves.*** You may get the best results when singing, with the can tight to your face. You can show students different patterns as your voice gets louder and softer, and especially so when you sing different notes. Sing loud and say, ***That sound was loud.*** Sing soft and say, ***That sound was soft.*** Repeat and allow students to identify sounds as loud or soft. ***We can hear loud and soft sounds.*** Allow students to take turns making sounds into the instrument. Point out the change in the light on the wall. Ask students, ***We can hear the sound vibrations. Can you show me when you see the vibration of the sound on the wall?***	Students can help make the new instrument, create sound in can. Identify sounds as loud or soft. Identify when vibration is occurring from light change on wall.	 RULE For the Day *Review Safety List. **Special Attention to: Rule # 1: Do listen to your teacher's directions before you start working. Rule #4: Do wait to touch materials until your teacher says it's ok.	-Follow directions to make instrument. -Identify items needed to make instrument (eye gaze, touch, point, grasp). -Make noise into can instrument. -Activate switch to start a noise into can instrument. -Identify verbally. -Use assistive technology (AT) device to identify loud or soft. -Raise hands when sound is loud. -Picture symbols for loud or soft sounds. -Point to light on wall. -Verbally identify vibration. -Activate switch to say 'vibration' or 'sound' at the appropriate time.

Figure 1. A sample of scripted lessons with embedded guided notes instruction from the Senses unit. *Note.* The notepad icon served as the discriminative stimulus for the teacher to know when to embed guided notes instruction. The highlighted text indicated what was on guided notes and the underlined word within the highlighted text indicated what needed to be filled in by the students. The bolded and italicized text in the second column indicated what the teacher was to read aloud for the SL component.

Maintenance. On completion of each unit (i.e., after 18 instructional sessions across three SLs and three SLs + GNs lessons), maintenance data were taken once per week. All participants received quiz administration individually on each of the six lessons in random order across three science units. All science instructions were terminated during maintenance.

Validity, Fidelity, and Reliability

Content validity. Content validity of the SLs, vocabulary, and key concepts for each unit were rated by a university-level science expert, who compared the lessons against the National Science Education Standards for alignment with the standards based on a 3-point rating scale (i.e., not aligned, aligned, strongly aligned). All lesson plans were rated as either aligned or strongly aligned with the standards. In addition, each lesson plan was validated by a university-level faculty who specializes in general curriculum alignment for students with intellectual disability. The evaluation consisted of a four-part review focusing on generalization indicators, performance targets, alignment with grade-level content standards, and Universal Design for Learning, specifically sensory impairments. A checklist was used to evaluate each of the four components. All lesson plans were edited based on the evaluation results, as needed, prior to intervention implementation. The content validity experts were not directly affiliated with this research study, but were involved in the conceptualization process of the *Early Science* curriculum (Jimenez et al., in press).

Procedural fidelity. Using a procedural fidelity checklist, the primary experimenter measured the accuracy of the teacher's implementation of the SL and SL + GN instruction for 39% of the intervention sessions. A universal checklist was created for all SL and SL + GN sessions. The checklist consisted of 24 instructional steps (e.g., reviewed vocabulary words using time-delay procedure, prompted students to fill in the L on the KWHL chart) to be completed by the teacher during each intervention session regardless of the specific content. Procedural fidelity was calculated by dividing the steps observed by the total number of applicable steps on the checklist and multiplied by 100. Procedural fidelity was 97% (range = 91%−100%).

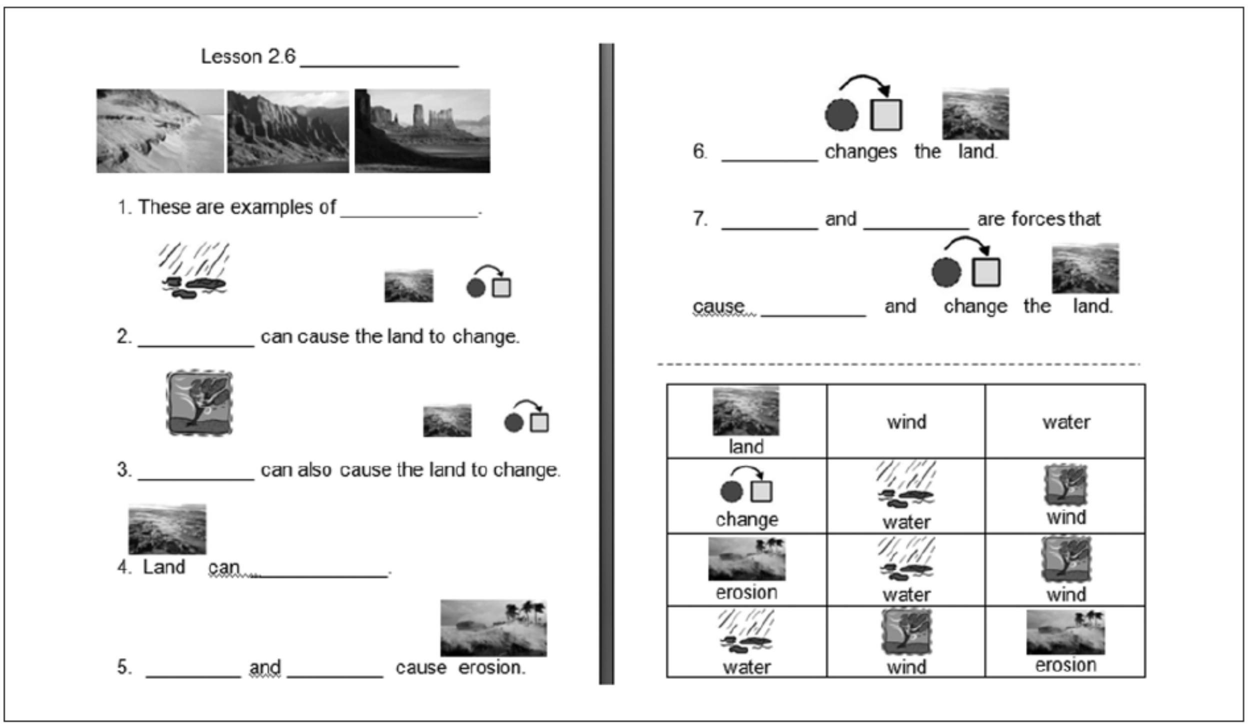


Figure 2. A sample of guided notes from the Life Cycle unit.

Interobserver reliability. Interobserver reliability data for the quizzes were collected by the secondary experimenter for 33% of the quizzes in each experimental condition for all participants. The interobserver reliability was compared using an item-by-item method and was calculated by dividing the number of agreed items by the total number of items on a quiz and multiplied by 100. The interobserver reliability was 100%. Interobserver reliability on the procedural fidelity of the teacher implementation was also completed by the secondary experimenter for 31% of the observed sessions across conditions and was 100%.

Social validity. At the conclusion of the study, the classroom teacher completed a social validity questionnaire to express her opinions regarding preference of the SL versus SL + GN instruction, the ease of implementation of both interventions, and the overall effectiveness of the interventions on students' science performance. The questionnaire consisted of four open-ended questions, one multiple choice question, and three questions based on a 5-point Likert-type scale.

The teacher reported that she preferred the SL instruction over the SL + GN intervention, which was much more cumbersome and time-consuming for implementation. However, the teacher did report that both interventions helped her students acquire the science content effectively.

Results

Table 2 shows the mean number of points each participant earned on science quizzes across all conditions and science units. Visual displays of results are presented in Figures 3, 4, and 5, for Kevin, Jamall, and Jackie, respectively. Kevin showed the most progress of the three participants from baseline (*M* = 5.3, mean range = 3.7−6.2) to the SL condition (*M* = 9.2, mean range = 8.4−9.6), as indicated by a clear change in level and stability. Kevin's data also showed a slight increase in points earned on quizzes for all three units from the SL instruction to the SL + GN intervention (*M* = 9.8, mean range = 9.3−10.0) considering his lower pretest scores and higher stability during the SL + GN condition. Jamall showed a change in level from baseline (*M* = 4.4, mean range = 4.0−5.0) to SL (*M* = 7.3, mean range = 6.3−8.8), and a slight change in level from SL to SL + GN (*M* = 7.8, mean range = 5.7−9.6) for the Life Cycle and Senses units. Jackie showed slight growth from baseline (*M* = 1.1, mean range = 0−1.9) to SL instruction (*M* = 3.2, mean range = 2.8−4.1) for all units; however, her improvement from SL to SL + GN condition was only clear visually for the Senses unit.

Table 2. Participants' Science Quiz Mean Scores (With Range) Across Units.

	Unit 1: Rock cycle				Unit 2: Life cycle				Unit 3: Senses			
Participants	BL	SL	SL + GN	*M*	BL	SL	SL + GN	*M*	BL	SL	SL + GN	*M*
Kevin	3.7 (0−5)	8.4 (7−10)	9.3 (7−10)	10.0 (NA)	6.2 (3−10)	9.6 (7−10)	10.0 (NA)	10.0 (NA)	5.9 (1−10)	9.6 (7−10)	10.0 (NA)	9.5 (7−10)
Jamall	4.0 (1−7)	6.3 (3−10)	5.7 (1−10)	6.5 (5−8)	5.0 (1−8)	6.7 (3−10)	8.2 (5−10)	9.7 (8−10)	4.3 (2−8)	8.8 (7−10)	9.6 (7−10)	9.0 (7−10)
Jackie	0.0 (N/A)	2.8 (0−5)	2.8 (0−5)	4.8 (2−8)	1.9 (0−7)	2.8 (1−5)	4.7 (2−10)	5.8 (0−7)	1.5 (0−5)	4.1 (1−8)	7.1 (3−10)	4.5 (3−7)

Abbreviations: BL = baseline; SL = scripted lessons; SL + GN = scripted lessons plus guided notes; M = maintenance. Numbers in parentheses represent range.

Furthermore, all three participants maintained their improved quiz scores during the maintenance condition at a level similar to or above the higher mean scores earned during the intervention conditions (either SL or SL + GN), with the exception of Jackie for the Senses unit.

Discussion

This study examined the effects of SLs with embedded systematic instruction and the additive effects of guided notes on the science quiz scores of three students with intellectual disability and autism. The results indicated that all participants improved their mean quiz scores during the SL condition over the baseline with two participants demonstrating slight improvement during the SL + GN condition over SL alone. In addition, all participants maintained their improved scores during the maintenance condition. However, a visual analysis of the graphic results reveals less conclusive findings for Jamall and Jackie.

During the baseline condition, the participants scored variably across the three science content units, with Jackie scoring at the lowest and more stable level on the science quizzes. Although the teacher delivered science instruction twice weekly, she relied on verbal description and explanation with limited level of constant time delay and with no other essential components of SLs. The instruction was based on the prescribed countywide curriculum because there were no published research-based curricula at the time of the study for students with severe disabilities. All lessons in the countywide curriculum were developed by a panel of selected special education teachers, but may not have included evidenced-based practices for teaching science to this population, such as systematic instruction (Spooner et al., 2011). Students were not engaged in active participation in the instruction. The baseline data indicated that all three participants' learning was limited and none of the participants met the mastery criterion of 8 points during the baseline condition. Kevin's earning of a full point on the two quizzes on the Life Cycle unit and two quizzes on the Senses unit may be indicative of his exposure to attending a science special area class once per week for 30 min with his typically developing peers. During the SL condition, all three participants improved their quiz scores with Kevin demonstrating most consistent improvement and meeting the mastery criterion for all three units. An analysis of the mean quiz scores showed that all participants made at least 0.9 mean point increase (i.e., 0.9-point increase for Jackie on Life Cycle unit to 4.7-point increase for Kevin on Rock Cycle unit) over the mean scores earned during the baseline condition, with the greatest score increases observed for the Rock Cycle and Senses units. The improved student demonstration of learning may be attributed to the inclusion of explicit instruction with discrimination training, time delay, and prompting methods used during the SL condition, supporting previous research's findings on the effectiveness of these approaches for students with moderate to severe disabilities (e.g., Ault et al., 1989; Browder et al., 2008; Downing, 2008; Doyle & Gast, 1990; Dymond & Orelove, 2001). The inconsistent and limited improvement for Jackie may be indicative of requiring more intensive instruction with higher number of repetition (e.g., teaching the same lesson five times instead of three times).

During the SL + GN condition, all participants showed a more consistent and slightly higher level of points earned on the science quizzes when compared with the scores received during the baseline and SL conditions, with the exception of Jamall and Jackie for the Rock Cycle unit. An item-by-item analysis of the student quizzes revealed that the participants attempted more to the open-ended question on a quiz and answered them correctly more during the SL + GN condition than during the SL alone condition. A plausible explanation may be that the guided notes used in this study provided the participants with a means to more actively interact with the instructional materials and content through multiple modalities of auditory, visual, and tactile to support their needs, a benefit of guided notes supported by previous research (Konrad et al., 2009; Lazarus, 1991; Stringfellow & Miller, 2005). As a result, the combination of SLs with discrimination training and the guided notes may have contributed to the participant’s ability to respond to higher order thinking questions.

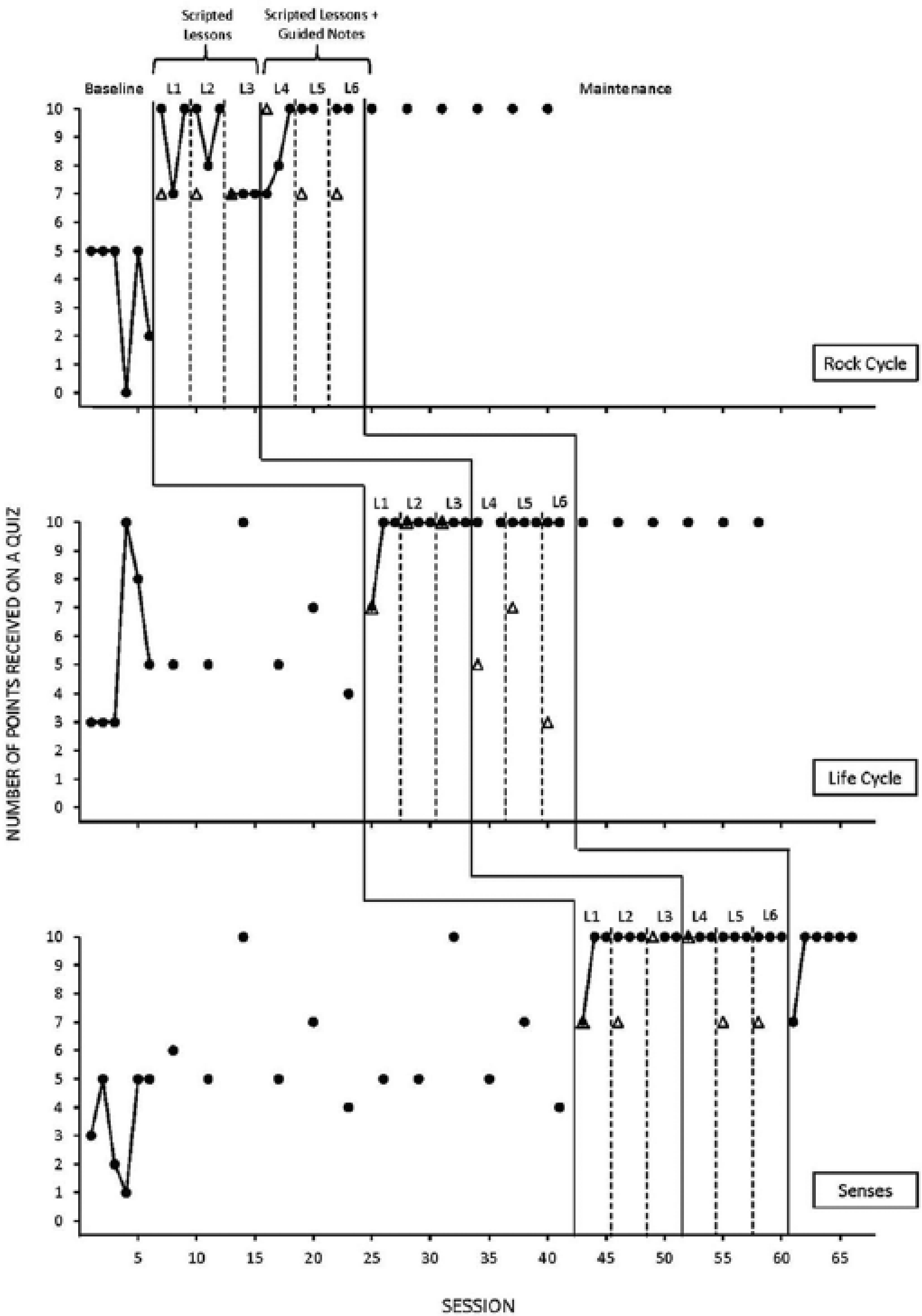


Figure 3. Number of points received on a quiz across conditions and science units for Kevin. Note. Open data points represent points received on the pretests; "L#" represents lesson number.

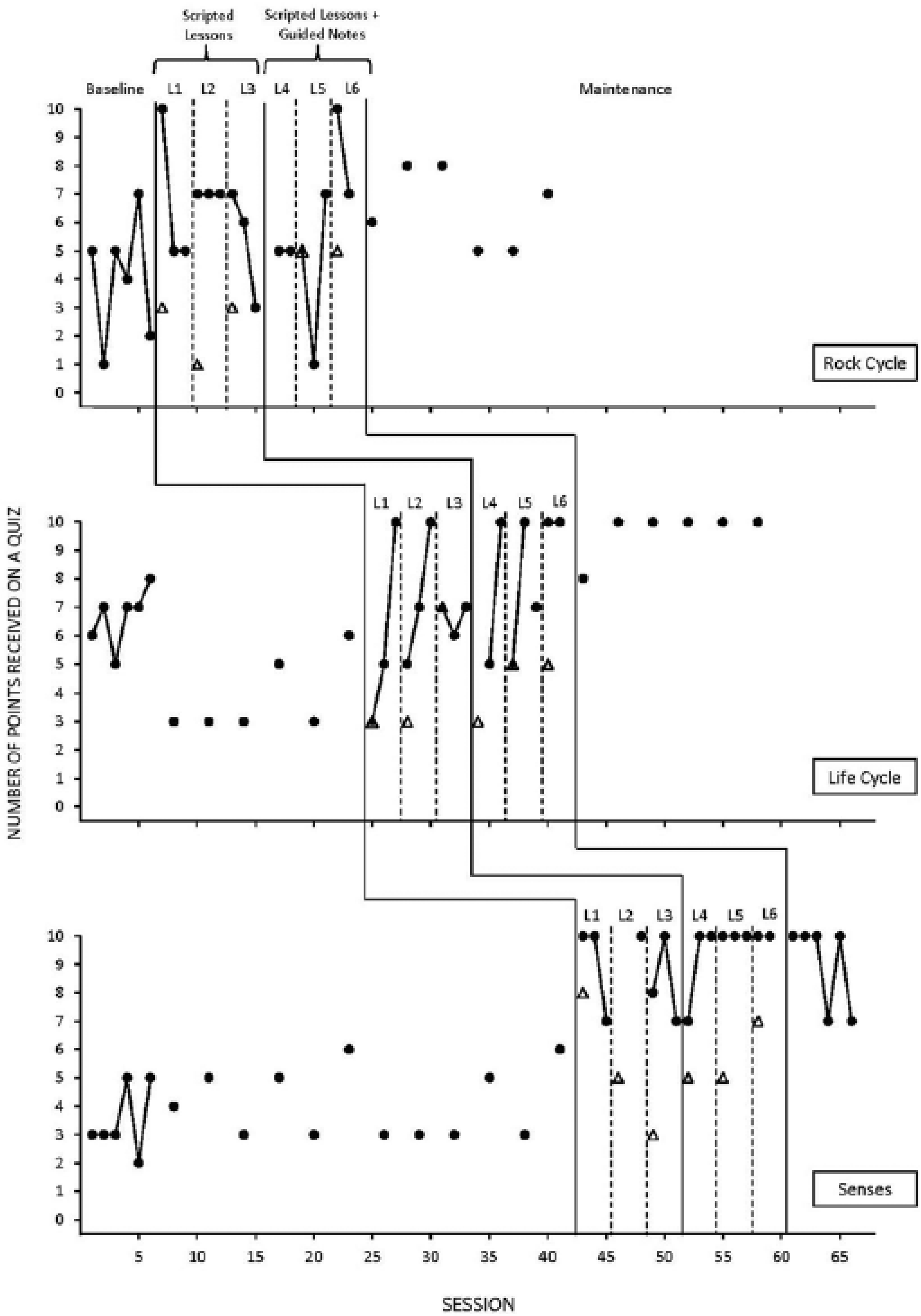


Figure 4. Number of points received on a quiz across conditions and science units for Jamall.
Note. Open data points represent points received on the pretests; “L#” represents lesson number.

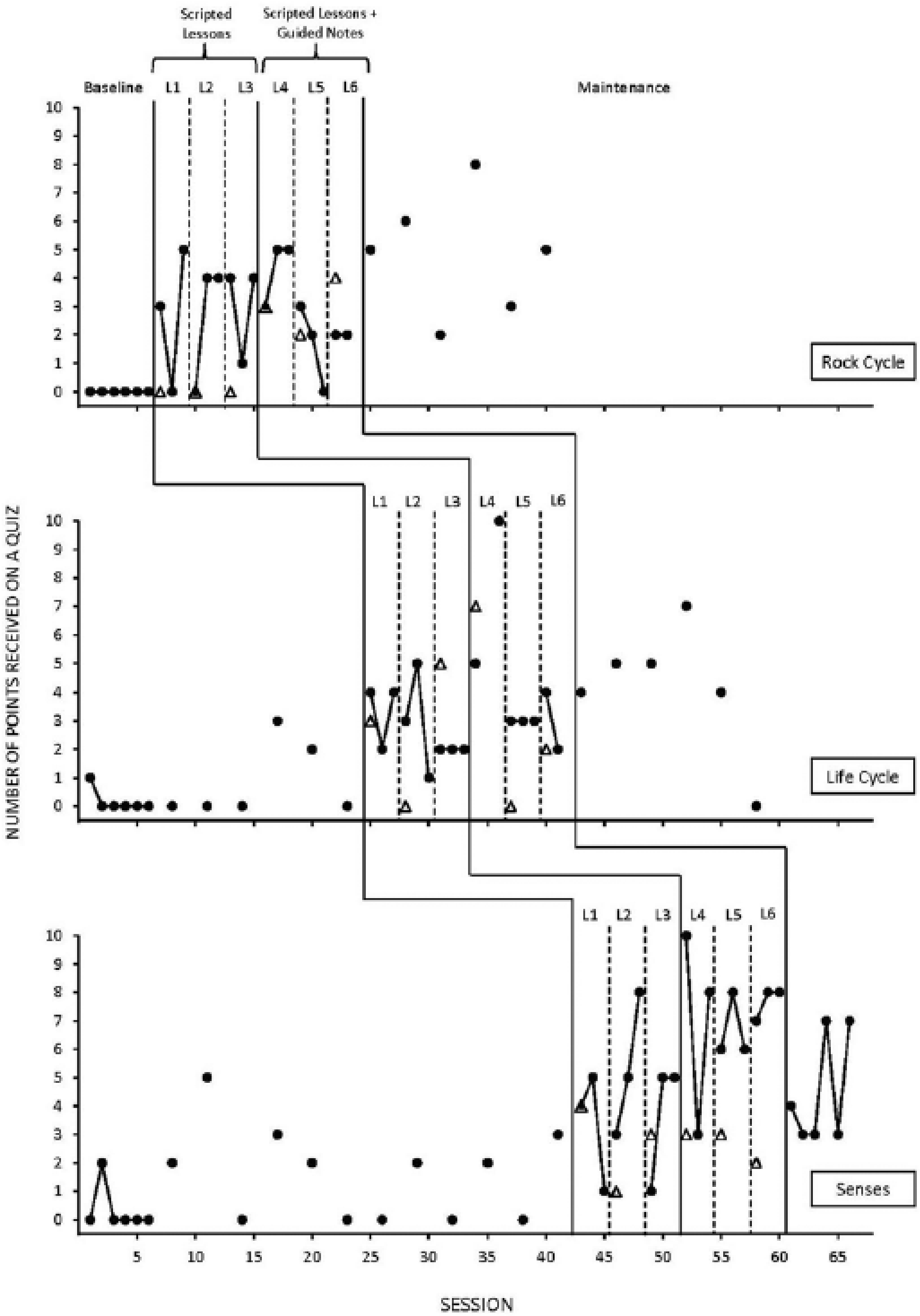


Figure 5. Number of points received on a quiz across conditions and science units for Jackie.
Note. Open data points represent points received on the pretests; "L#" represents lesson number.

Overall, there was a moderate level of variability in the results across lessons within units during the intervention conditions, especially for Jamall and Jackie. Two possible explanations include the novelty of the instructional method and the pace at which the lessons were introduced. First, the participants had never been taught using SLs during science instruction prior to this study. The process of becoming familiar with the instructional format for students with autism, who often required consistent and “routine-like” instruction, may have led to moderate variability in data. Second, each lesson was only taught three consecutive days before the next lesson was introduced to replicate traditional pacing guides used by the school system and to be practical in a group instructional setting. For a teacher to provide adequate instruction on all units and concepts to be taught within a school year (e.g., what will be assessed), the teacher must introduce and teach key concepts within a unit and continue to move to new materials within a reasonable amount of time (e.g., weekly). However, students with moderate and severe intellectual disability often require more than three instructional sessions to learn new academic skills to mastery and maintain skills over time, which may have accounted for some participants’ low level of earned points on the science quizzes. In addition, a large part of the scripts required students to listen without actively responding. Anecdotal notes from observations suggested that many students’ attention span was short and they often looked away from the teacher and the science materials during the “listening” portion of instruction. Each intervention lesson was quite lengthy (e.g., 45 min from start to finish), which may have contributed to the students’ low attending levels, consequently affecting students’ learning. This also may have partially explained the additive effects of guided notes in this study.

Among the three participants, the quiz performance results for Jackie were least conclusive, possibly because of two reasons. First, the reliance on auditory processing and receptive language required of students during SLs was very high. According to the results from the *Receptive One- Word Picture Vocabulary Test* (Martin & Brownell, 2005), Jackie’s receptive language scores were at 1 year, 10 months. Jackie’s low receptive skills limited her in accessing the instructional content during all SLs. Second, Jackie had a high degree of distractibility and often engaged in excessive behaviors such as rocking, high-pitch laughing, and bouncing during longer lessons. The 45-min lessons presented an extra challenge for Jackie to attend to the instruction. Instructional modifications such as individualized instruction addressing her receptive language levels, shortened lessons with intensified reinforcement contingency system for attending to instruction, a higher level of repetition in skill practice, and performance feedback on quizzes may be appropriate for Jackie.

Limitations and Directions for Future Research

Despite the positive outcomes, there are several limitations to this study. First, because of practical reasons, each lesson was delivered three times and three lessons were devoted for each type of the instructional method (SL or SL + GN) as the primary rule for decision making to move on to the next lesson or next condition. This limited the demonstration of a functional relationship between the interventions and the dependent variable within a single-subject research paradigm for the study. However, a more rigorous decision making guideline that is applicable for individual students (e.g., changing a condition when a student met the mastery criterion) is not possible within a group instruction setting. Future studies may address this issue by considering the application of the response to intervention (RtI) model for the science instruction for students with moderate to severe disabilities by delivering the SL or SL + GN instruction as Tier 1 intervention and providing additional Tier 2 intervention concurrently to students such as Jackie to address their learning needs. Within such a RtI model, a teacher assistant, paraprofessional, or other school personnel may be involved in the implementation of the tiered instruction, which can be an area for future research to demonstrate how various teachers and school personnel may be effective interventionists of scripted and guided notes instruction for students with moderate to severe intellectual disability.

Second, the open-ended question in each quiz required a participant to generate a response and was worth 3 points with no partial point earning. Because not all open-ended questions required multiple answers (e.g., "Name three things that plants and animals need to live."), awarding partial points would have resulted in inconsistent scoring. As a result, the data may have underestimated the participants' actual learning when they demonstrated parts of the responses correctly for an open-ended question. In addition, the mastery criterion was set at 8 points. To reach the mastery criterion on a quiz, a participant must answer the open-ended question correctly, which was in nature the most difficult question on a quiz. This made it more difficult for a participant to reach the mastery criterion when he or she might have just missed a portion of the correct answers for the open-ended question. Future research may consider a more sensitive and consistent scoring system for the academic achievement measurement.

Third, there might be some carryover effects from lesson to lesson and possibly from unit to unit in terms of the inclusion of the same key vocabulary (e.g., "living" and "changes"). It is natural for science lessons to share the same key vocabulary essential for content continuality. Future studies should attend to the possible carryover effects possibly derived from between-units by considering a multiple probe across groups or classes design, which was not practical for this study because of the group instruction nature of the study.

Finally, all instructional sessions were delivered in a self-contained special education classroom by a special education teacher. Access to the general education curriculum was integrated in the study by aligning the instruction with the National Science Education Standards and the State's grade-level content standards; however, the inclusive nature of the participants to receive instruction with typically developing students in a general education setting or the generalization measure of participant's skills to the general education setting was not investigated. Future researchers should consider evaluating generalization effects to the general education classroom and/or investigating effective ways to integrate the interventions in an inclusive setting for students with moderate to severe intellectual disability.

Implications for Practice

This study contributed to the limited research on science instruction for students with moderate to severe intellectual disability by addressing general curriculum content alignment, embedding effective instructional strategies for this student population, and by extending science content standards to *Earth and Space Science*, *Life Science*, *Physical Science*, and *Science as Inquiry*. Although special educators can write SLs using the guidelines set forth by Gunter and Reed (1997) to include all essential components, this process can be very time-consuming and all lessons need to be validated by content experts to ensure accuracy of content included. Thus, it is more feasible for teachers to use SLs in research-based, published curricula such as the one used in this study. Furthermore, some special education teachers in self-contained classrooms for students with moderate to severe intellectual disability and autism may not be content experts in the academic areas in which they teach. Published SLs are beneficial to special educators because they provide support for teaching academic content in a manner that incorporates research-based strategies. In addition, the use of SLs + GNs in combination ensures that teachers are providing pertinent information within the academic content area in a clear and concise manner. However, educators should be cautious in limiting lengthy explanations during SLs, which can present a challenge for some students with autism who have language processing delays. Providing explanations in short segments with additional opportunities for active student responding (e.g., guided notes or choral responding) throughout the lesson may be beneficial in raising the academic performance of students with moderate to severe intellectual disability and autism. This approach may also help students with both attending and language processing difficulties. Special education teachers may also need to adapt materials included within the published SLs for the specific needs of their students in the classroom, such as students who are deaf, are blind, have sensory impairments, have motivational issues, or have other physical limitations. In some cases, specifications for such adaptations for individual students' needs are provided in published curricula. For example, educators can find directions on how to adapt the SLs and materials in the *Early Science* curriculum (Jimenez et al., in press) manual to ensure the instruction is accessible to all students.

Authors' Note

The conceptualization and analysis for this project took place while Bree Jimenez was a Research Associate at UNC Charlotte.

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